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NAVAL OCEANOGRAPHIC OFFICE NSTL STATION MS  
COMMERCIAL ALGAE IN THE COASTAL WATERS OF THE SHANTARSKY ISLAND--ETC(U)  
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PROMYSLOVYYE VODOROSLI PRIBREZHNYKH VOD

SHANTARSKIKH OSTROVOV

(Commercial Algae in the Coastal Waters of the Shantarsky Islands)

O. S. RYBAKOV

pages 160 - 164 in TINRO Pacific Ocean  
Scientific Research Institute of Commercial  
Fishing and Oceanography, v. 75, 1971

1978

TRANSLATION



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RECEIVED  
OCT 5 1979  
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Translator: V. Astvazaturov  
Editor: J. Duncan

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NAVAL OCEANOGRAPHIC OFFICE  
NSTL STATION, BAY ST. LOUIS, MS 39522

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(14) NOO-T-34(608)

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER NOO Translation T-34 (608)	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Commercial Algae in the Coastal Waters of the Shantarsky Islands (PROMYSLOVYYE VODOROLIE PRIBREZHNYKH VOD SHANTARSKIKH OSTROVOV)		5. TYPE OF REPORT & PERIOD COVERED
7. AUTHOR(s) O. S. /Rybakov		6. PERFORMING ORG. REPORT NUMBER
9. PERFORMING ORGANIZATION NAME AND ADDRESS U. S. Naval Oceanographic Office ✓ NSTL Station Bay St. Louis, Mississippi 39522		8. CONTRACT OR GRANT NUMBER(s)
11. CONTROLLING OFFICE NAME AND ADDRESS U. S. Naval Oceanographic Office NSTL Station Bay St. Louis, Mississippi 39522		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 11 1978
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		12. REPORT DATE
		13. NUMBER OF PAGES 129
		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report)  Approved for public release; distribution unlimited		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES 31 Trans. of Translation of pages 160-164 in TINRO (Pacific Ocean Scientific Research Institute of Commercial Fishing and Oceanography, v. 75, 1971 v75 p160-164 1971, by V. Astvazaturov.		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) MARINE BIOLOGY OKHOTSK SEA ALGAE SHANTARSKY ISLANDS		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) Marine algae reserves around the Shantarsky Islands were surveyed in August 1965 and August through September 1966. Dives were made at 400 stations. Commercial quantities of three species were found: <u>Laminaria gurjanovae</u> A. Zin, <u>L. digitata</u> (Huds) Lam. and <u>Lessonia laminoriodes</u> Post et Rup. 250 450 JOB		

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95. KEYWORDS	96. IDENTIFIERS
97. CLASSIFICATION	98. SECURITY CLASSIFICATION
99. DATE	100. AUTHOR

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

Commercial Algae in the Coastal  
Waters of the Shantarskiye Islands

by: O. S. Rybakov

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UNANNOUNCED	<input type="checkbox"/>
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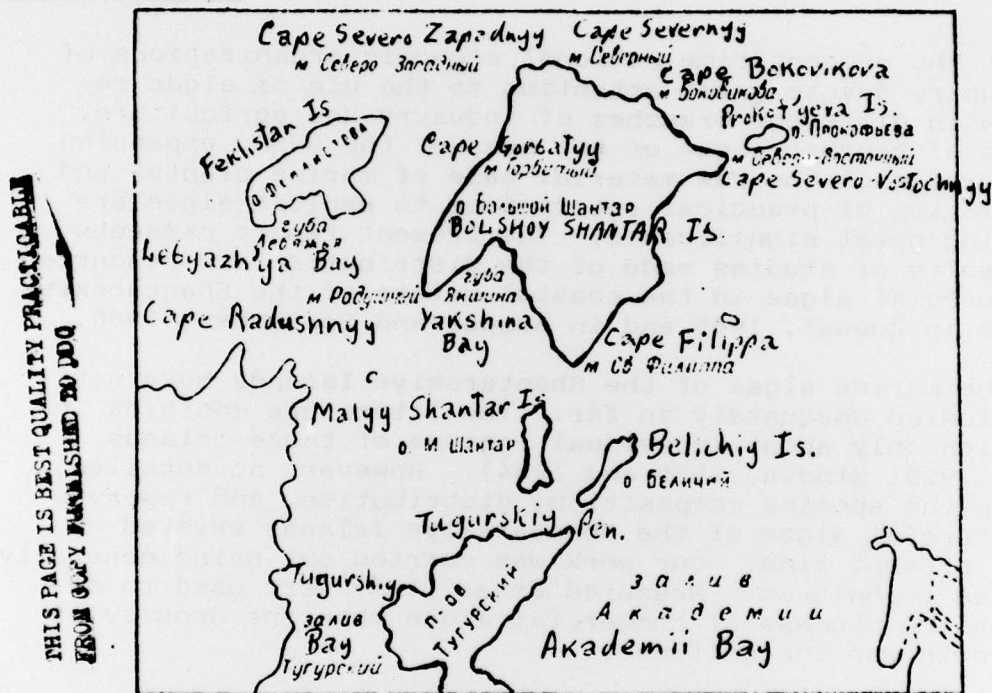
At the present time national economic organizations of our country devote great attention to the use of algae resources in different branches of industry and agriculture. Studies of benthic algae of the seas of the USSR, expansion of knowledge of the raw material base of marine plants, and organization of practical enterprises to exploit algae are acquiring great significance. The present report presents the results of studies made of the distribution and resources of commercial algae in the coastal waters of the Shantarskiye Islands in August, 1965 and in August and September, 1966.

The marine algae of the Shantarskiye Islands have not been studied adequately so far. The literature contains information only about individual regions of these islands (Zaks, 1929; Zinova, 1930 and 1954). However, no detailed data on the species composition, distribution, and reserves of commercial algae of the Shantarskiye Islands existed up to the present time. Our work was carried out using generally accepted techniques. Measured areas ( $1m^2$ ) were used to determine the biomass of commercial algae when the density of overgrowth was insignificant.

The reserves were computed on the basis of average algae biomass, width of overgrowths, their density, and the length of shoreline. More than 400 diving stations were completed during both work periods.

The Shantarskiye Islands are located north of the Akademy and Tugurskiy Bays in the southwest Sea of Okhotsk. This island group consists of four large islands, Pol'shoy Shantar, Feklistova, Malyy Shantar, and Belichiy, and several much smaller islands (see figure). The investigations were carried out only in the coastal waters of the large islands and established that, in the coastal waters of the Shantarskiye Islands, commercial algae are distributed unevenly from the standpoint of species compositions and biomass. Only three species have been found in commercial quantities near the Shantarskiye Islands: Laminaria gurjanovae A. Zin., L. digitata (Huds.) Lam., and Lessonia Caminariodes Post et Rupr.

Bol'shoy Shantar Island is the largest island in the group. Yakshina Bay contains the largest reserves of commercial algae. From Cape Filippa, the southern extremity of Bol'shoy Shantar Island, almost to Cape Raduzhnyy, commercial algae are represented by one species - Laminaria gurjanovae, if one disregards individual encounters with Lessonia Caminarioides and Laminariodes digitata.



## Shantarskiye Islands

The morphologic structure of Laminaria gurjanovae assigns it to the "saccharin" group, but it differs from all other species of laminaria of this group in a number of features. The main distinguishing feature of this species is the dual character of the blade in commercial, second-year specimens: the lower part of the blade has the shape of a narrow wedge, is rough, and has straight or slightly wavy edges. The soruses (sori) develop mainly on the thin half of the blade, while a greater part of the thick half remains sterile. Laminaria gurjanovae inhabits principally the sublittoral zone at depths less than 15 m, but occasionally is deeper.

In the Cape Filippa region, Laminaria gurjanovae grows at depths of 4 to 6 m. The growths have a mean width of 60 m where the coverage is 80 percent, which shows the



density of the cover. The biomass reaches  $14.4 \text{ kg/m}^2$ . Farther toward the apex of the bay, the growths are in 1 to 14 m of water and are 1,200 m wide. However, the biomass is several times smaller in this region. Another commercial species, Laminaria digitata, appears closer to Cape Radushnyy. Based on its thallus, this species belongs to the blade-kelp group "with a split blade". Laminaria digitata grows in the sublittoral zone at a depth of 3 to 15 m. The biomass of this algae ( $0.5 \text{ kg/m}^2$ ) is very low compared to that of Laminaria gurjanovae.

Closer to Cape Raduzhnyy, picture is the same as near Cape Filippa. The width of Laminaria gurjanovae growth here decreases to less than 500 m, while the biomass quadruples, reaching  $9.2 \text{ kg/m}^2$ . Laminaria digitata is absent in this sector. Generally, more than half of the commercial algae reserves of this region are confined to the coastal areas near capes at bay entrances, even though these areas are a small part of the whole coastal region. The water exchange (circulation) is better in these regions and there is no dilution by fresh water.

From Cape Raduzhnyy to Cape Severo Zapadnyy, commercial algae growths, especially Laminaria gurjanovae, extend along the entire coast of the island at depths of 2.5 to 11 m. On the Cape Gorbatty traverse, at depths of 11 to 12 m, growths of Laminaria digitata may be present, but its biomass and density is low. Along the west coast, Laminaria gurjanovae biomass is 2.6 to  $5.8 \text{ kg/m}^2$ , but increases near the capes. However, the growth is narrower here.

The northeast coast is the only place in the Shantarskiye Islands where no commercial growth of Laminaria gurjanovae was found. There are two species of commercial algae in this region: Laminaria digitata (previously discussed) and a new species, Lessonia laminarioides. The thalluses (thalli) of Lessonia laminarioides resemble bushes up to 150 cm high, with blades 100 to 150 cm long and 10 to 20 cm wide, with a narrow base and rounded top. Near the northeast coast, Lessonia grows southeast of Cape Severnyy at a depth of 1 to 2 m with a growth width of 50 m. The narrowness of the growth is compensated for by a population density of more than 80 percent. In this area, Lessonia biomass is  $0.8 \text{ kg/m}^2$ .

Laminaria digitata extends along the entire coast except for a sector southeast of Cape Bokcikov where there are no algae. The absence of Laminaria gurjanovae near the northeast coast is hard to explain at the present time. Apparently, the rate of water circulation has some effect, because decreased water exchange inhibits the oxygen exchange of algae. (Gur'yanova, Zaks, Ushakov, 1925).

Near the east and southeast coasts of Bol'shoy Shantar



Island, all three species of commercial algae are found: Laminaria gurjanovae, Laminaria digitata, and Lessonia. Laminaria accounts for the largest part of the biomass of the commercial algae reserves in the area where it grows. The total reserves of Bol'shoy Shantar Island commercial algae are 186,200,000 kg, while the quantity per kilometer of shoreline is 700,000 kg. Yakshina Bay and the west coast, where there are 1,440,000 kg of commercially exploitable algae per kilometer of shoreline, have the greatest production (18,110,000 kg). Feklistova Island is the second largest of the Shantarskiye Islands. Laminaria gurjanovae is the only commercial algae growing in Lebyazh'ya Bay. Its biomass fluctuates from 1.8 to 2.6 kg/m<sup>2</sup>. The area covered by algae is larger because Lebyazh'ya Bay is shallow. Laminaria gurjanovae grows at depths of 0.5 to 12 m and forms growths up to 3,500 m wide with 30 to 60 percent coverage. Consequently, despite the very low biomass, the commercial algae reserves in Lebyazh'ya Bay are two-thirds of the total quantity near Feklistova Island. Along the open south coast, Laminaria gurjanovae growths decrease to 100 to 250 m wide. The main commercial species on the northwest and east coasts of Feklistova Island is also Laminaria gurjanovae. Laminaria digitata, local reserves of which are twice as large as those of Laminaria gurjanovae, predominates along the north coast. The total reserves of commercial macrophytes around Feklistova Island are estimated to be 99,300,000 kg and their quantity per kilometer of shoreline reaches 720,000 kg. The south coast, its open part and Lebyazh'ya Bay, and the northwest coast, where reserves per kilometer of shoreline comprise approximately 1,000,000 kg, are the regions with the greatest reserves (91,800,000 kg).

Belichiy and Malyy Shantarskiye Islands are located between Tugurskiy Peninsula and Bol'shoy Shantar Island. In the coastal waters of both islands, reserves of commercial algae are represented by three species of macrophytes, among which Laminaria gurjanovae predominates.

Regions with the greatest accumulations of commercial algae are the south and east coasts of Malyy Shantarskiye Island and the northwest coast of Belichiy Island, where the reserves are respectively 40,000,000 kg and 7,000,000 kg.

The following mass representatives of red algae were frequently found during the Shantarskiye Islands study: bladed algae- Crossocarpus lamuticus Rupr., Turnerella mertensiana (Post. et Rupr.) Schmitz., Rhodymenia pertusa (Post. et Rupr.) J. Ag. et al., bushy algae- Odonthalia, Ptilota and Halosaccion Tichocarpus crinitus (Gmel.) Rupr. Chondus crispus (L.) Lyngb. and Ahnfeltia.

\*Given weight of algae is the raw weight.

Among the bladed algae, the genus and species Odonthalia are distributed quite evenly through the coastal waters of the Shantarskiye Islands and grow abundantly at 7 to 13 m depths. Tichocarpus prefers bays, while different species of Ptilota develop near open coasts and live in the middle and upper sublittoral zone at a depth of 2 to 5 m. Halosaccion inhabit the littoral zone, while Chondrus grows in the littoral and sublittoral zones at depths of less than 15 m. Ahnfeltia were found in insignificant quantity (only the sessile form) near Cape Filippa, near the west coast of Bol'shoy Shantar Island, in Lebyazh'ya Bay, near Feklistova Island, near Malyy Shantar (Cape Severo-Vostochnyy) and near Belichiy Island (southern end of the northwest coast).

The results of the investigations carried out in 1966 were also analyzed. Analysis of the 2-year study indicated that macrophyte reserves fluctuate annually. The reserves of brown algae reached approximately 60,000,000 kg (100 million predicted) in 1966. The growth and spore formation processes were somewhat retarded. In August 1965, half of the investigated thalluses were covered with soruses (sori) of sporangia, while in 1966 spore formation was observed only during mid-September. The thalluses's (thalli) weight and size were significantly smaller than in the previous year, and the biomass density and width of the growths also were smaller. The total reserves were also low.

In 1966, the following four new (for this region) species of brown algae were found in commercial quantities near the Shantarskiye Islands: Cystoseira geminatum (Ag.) J. G. Ag., Desmarestia viridis (Mull.) Lam., Agarum cribrosum Bory, and Alaria sp. Their total reserves are approximately 5,000,000 kg.

The frequency of occurrence of red algae was either higher than or at the same level as in 1965, with only two exceptions where they were fewer. In spite of the fact that red algae are found almost everywhere, their biomass is insignificant, does not exceed  $1 \text{ kg/m}^2$ , and is on the average  $200 \text{ g/m}^2$ .

In 1966, sessile Ahnfeltia were found in new regions: near the northwest and east coasts of Feklistova Islands, in Yakshina Bay, near the southeast coast of Bol'shoy Shantar Island, in Abrek Cove on Malyy Shantar Island, and off its open south coast; but the biomass of this plant did not exceed  $400 \text{ g/m}^2$ .

Summing up the above, one reaches the following conclusions:

1. Based on survey data, it was established that the coastal waters of the Shantarskiye Islands are characterized by rich, commercially valuable, but unevenly distributed growths of Laminaria algae. The main mass, despite cyclic variations in growths of commercial age, is confined to the following regions: Bol'shoy Shantar Island (Yakshina Bay and the west coast); Feklistova Island (Lebyazh'ya Bay, the open part of the south coast, and the northwest coast); Malyy Shantar Island- south and east coasts; Belichiy Island- northwest coast.
2. Commercial algae reserves of these sectors comprise 90 percent of the total reserves near the Shantarskiye Islands and fluctuate from 1,200,000,000 to 3,200,000,000 kg (excluding anomalous years).
3. Consequently, large reserves of Laminaria in the Shantarskiye Islands region can support an algae industry with organized mechanical harvesting. The optimum time for harvesting Laminaria is August, because spore formation culminates in September when the length and width of the blade decreases, which leads to significant losses in the weight of the thalluses (thalli), while in August most of them are sterile. Laminaria gurjanovae, which comprises 90 percent of the total reserves in the areas recommended for commercial exploitation, predominates among the commercial macrophytes.
4. Red algae are found everywhere in this region, consequently, the search for algae containing agar-like substances should continue in this region, as well as in other coastal sectors of the Sea of Okhotsh. However, investigation of such a peculiar group of plants as the red algae requires more than that allotted in 1965 - 1966.
5. In order to determine the reserves of red algae in the areas where mass growths were found, one must make a more thorough and detailed survey, because these aquatic plants do not form growths over large areas and they require a denser network of stations. The need for this type of study is dictated mainly by the fact that red algae are the raw material for the manufacture of agar and agar-like substances that are so desperately needed by the national economy of our country.



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